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ABSTRACT

The Industrial Development Bank of India (IDBI) is the premier institution in India purveying financial assistance to the industrial-sector projects. Its annual lending amounts to $6 billion. Recognizing the need to increase lending for energy efficiency and environmental management (ee/em) projects, the Asian Development Bank (ADB) provided a $150 million line of credit to IDBI. These funds were lent to cement, steel, paper, sugar and other industries. Accompanying the line of credit, ADB also provided funds for technical assistance to strengthen IDBI's capability for the assessment of projects related to energy efficiency and environmental management (ee/em).

The technical assistance (TA) focused on IDBI's institutional capability, the procedures it follows for lending in this area, studies of ten energy-intensive sectors, and training and data needs to improve its lending. The findings of the TA reveal a need to (1) use ee/em indicators during IDBI's appraisal, approval, and monitoring of projects, (2) increase the ee/em information resource base – in-house and out-house ee/em experts, handbooks, computerized data bases – that IDBI staff can access, and (3) increase awareness of ee/em components among industrial borrowers. The sector studies show that there is at least a 20% lag compared to best practice for energy use, and that a significant potential, $1.0 billion, exists for investment in ee/em activities. These activities include (a) housekeeping measures such as improved lighting, variable-speed motors/drives, improving power factor, etc., (b) installing co-generation and captive power generation units, and (c) changing manufacturing processes to more efficient and less polluting ones. Training and data needs were also identified which would improve IDBI's lending for energy efficiency and environmental management.

1. Introduction

Beginning in 1955, several financial institutions (Development Finance Institutions (DFIs) were established to provide funds to the large medium and small industry in India. The DFIs provide finance for the establishment of new industrial projects as well as for expansion, diversification, and modernization of existing industrial enterprises. In 1997-98, the Industrial Development Bank of India (IDBI) and the Industrial Credit and Investment Corporation of India (ICICI), the two largest DFIs, for instance, provided $12 billion worth of financing. In recent years, DFIs have been active in managing and lending for energy efficiency and environmental projects. Because of their role in lending for industrial institutions, the DFIs are in a position to transform the market for industrial energy efficiency and environmental pollution control activities.

We evaluated this potential role for IDBI in lending for energy efficiency and environmental pollution control activities. The Asian Development Bank (ADB) had provided IDBI a $150[1] million loan for the Industrial Energy Efficiency Project (IEEP) at the request of the Government of India (GOI) to improve energy efficiency in the modernization and expansion of industry. The primary energy efficiency criteria for the selection of industrial projects were that the modernized or expanded plant show at a minimum an energy efficiency improvement of 18%. In addition, a technical assistance (TA) project accompanied this line of credit to IDBI. This TA project formed the basis for our evaluation.

The project consisted of two main activities. The first was to evaluate the investment potential for ee/em activities or projects in ten industrial sectors, and the second was to examine the suitability of IDBI's current institutional structure, and policies and procedures, for ee/em lending on a regular and organized basis. The evaluation of ten industrial sectors revealed an investment potential, with a payback period less than four years that exceeded $ 1 billion. The IDBI evaluation identified many areas where the establishment of an energy and environmental center within IDBI would accelerate the achievement of this potential.

In addition to the above two main activities, the consultant's team also conducted in-house seminars, overseas training programs and site visits to steel, paper and aluminum plants, organized outreach workshops for industry, and provided bibliographic information on ee/em for the IDBI library.

The TA was managed by a US company, Energy Resources International (ERI), with primary responsibility for the technical aspects covered by the Lawrence Berkeley National Laboratory (LBNL), University of California, and Dalal Consultants and Engineers Ltd. from India. In addition, Indian sector specialists were hired to study the potential for energy efficiency improvement and environmental management in ten industry sectors. In order to facilitate the work of the ERI team, IDBI established a Task Force comprising of five IDBI officers.

The project produced ten reports, one each for the aluminum (Roy et al. 1998), cement (Karwa et al. 1998), chemicals (Fatnani et al. 1998), copper (Mitra et al. 1998), fertilizer (Trivedi et al. 1998), iron and steel (Mishra et al. 1998), pulp and paper (Srivastava

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[1] As of 31 October 1998, loan applications worth approximately $125.19 million funded by IEEP had been authorized.

et al. 1998), sugar (Prabhakar et al. 1998), textiles (Hirani et al. 1998), and zinc (Krishamurthy et al. 1998) sectors. The sector reports include information on status of the industry, technologies, energy use and comparisons, energy conservation potential, costs and benefits of energy efficiency, and environmental concerns. For the cement, fertilizers, pulp and paper, sugar, and textiles sectors, separate summary reports were prepared for the industry audience. In addition, a report documenting and reviewing IDBI's institutional structure and its procedures for lending to industrial projects was prepared. Finally, a bibliography of journal and popular articles, books and conference proceedings was prepared for each sector for use by the IDBI library to add to its current collection of material on topics in these sectors.

2. Summaries of Sector Studies

The industrial sector provided 29% of India's GDP in 1994-95 and manufacturing accounted for 20 % of the GDP. The sector is a significant consumer of materials and energy and an emitter of environmental pollutants. While energy costs account for only 4.7% of manufacturing output, their share are significantly higher in the energy-intensive industries. These industries also tend to be heavy polluters because of their intensive use of raw material, which is transformed into a usable product while discarding the unusable portion, such as red mud in the production of aluminum. Below, we provide background information on the development of the manufacturing sector in India, with particular emphasis on the growth and productivity improvements of selected industries.

2.1 Sector Studies

The sector studies consumed bulk of the effort of this technical assistance. Ten industry sectors: chemicals (caustic soda), steel, fertilizers, cement, textiles, pulp and paper, aluminum, zinc, copper, and sugar were selected for study. Each sector report includes a description of the sector, technologies and processes used to manufacture the primary products in that sector, energy use in Indian plants and those in other countries, potential for reducing energy use and the associated cost, and environmental norms in that industry. Also included in each sector report is a list of suppliers for the equipment used in that industry, and a list of items that IDBI loan officers could check when appraising a loan for each sector, and information on the size of the market for energy efficiency and environmental management investments in each industry.

The primary conclusion from these studies is that in every sector there are cost-effective opportunities to reduce energy use, and pollutant loadings, and to improve the financial performance of the respective industrial plant. These opportunities remain untapped due to many barriers such as: the cost or availability of financing, lack of availability of information and access to equipment and technology.

The main challenge in preparing the sector reports was the difficulty in acquiring information on the costs of improving energy efficiency. Cost information is difficult to obtain since bids provided by equipment suppliers vary with the circumstances under which they are being sought by the buyer. Therefore, the actual costs may vary considerably across companies and loans. Selected findings of the sector reports are summarized below.

2.2 Production Capacity and Technology

India is a major producer of several energy intensive commodities. It ranks among the top five producers worldwide of aluminum, cement, steel, fertilizers, textiles, sugar, and paper. The demand for these products is growing faster than that worldwide because of the steady and relatively faster economic growth, and increased materialization of the Indian economy. The construction sector, which constitutes a major demand for products such as steel, cement, aluminum, etc., has grown faster than the rest of the Indian economy and as infrastructure expansion is targeted by the Indian government; demand for these products is likely to increase in future. The quality of the technology being used to produce these products varies across sectors, but a few common features are worth observing in this context. We report on the findings for the aluminum, cement, steel, fertilizers, and caustic soda sectors.

The production of <u>aluminum</u> is dominated by older technology. All the existing plants are based on foreign process know-how. They are of older design, however, wherein negligible process automation has been introduced, except in the case of one major plant owned by the National Aluminum Company (NALCO). In part because of their vintage, Indian plants lag in their efficiency of electricity use, which ranges from 14,500-23,000 kWh/tonne for the aluminum extraction plant, compared to 13,500 kWh/tonne for the best plants abroad.

Almost all the process steps in Indian aluminum plants can be improved with modification/ retrofitting and substantial scope exists for using energy more efficiently. Important areas, which could lead to significant reduction in energy consumption, include replacement of existing rotary kiln with statutory calcinator, adoption of tube digestion system in place of autoclaves, use of variable speed drives for major process pumps and large motors, introduction of microprocessors and computer based cell operation, etc.

Various varieties of <u>cement</u> are being manufactured employing three main technologies: the dry, the semi-dry and the wet process. The dry process provides significantly more modern and energy efficient technology. Over time, the wet and the semi-dry processes have increasingly been replaced by the dry process through addition to the dry-process capacity, as well as conversion from the wet to dry process.

Coal is the major fuel used for heat production in the cement industry. The dry process uses between 750-800 kcal/kg of cement clinker compared to the more energy-intensive wet process, which uses between 1350-1500 kcal/kg of clinker. The electricity consumption of cement plants averages around 120 kWh per tonne of cement produced. Conversion of all 61 kilns (8.5 mt) operating on wet process in India to the dry process could save 1.2 mt of coal, which in turn could be used to manufacture 7.8 mt of cement. About 25% of the wet process capacity is amenable to conversion,

The production of <u>caustic soda</u> is very energy intensive, with almost 50% of the value of the raw material being electrical power. Older plants all rely on mercury cells that release significant amounts of mercury in the environment causing a serious toxic hazard. In Indian plants the electrolysis power for the membrane plants (i.e., exclusive of auxiliary power consumption) per ton of caustic soda is 2700 kWh/t. The older diaphragm plants use about 4000 kWh/t. The lowest numbers are for the membrane process plants. The mercury-cell plants (which today dominate the Indian installed capacity) use 3500 kWh/t. Energy efficiency of individual membrane plants varies because of the age of the plant, rectifier efficiency, level of automation, and the level of cell instrumentation and control.

Energy efficiency upgrades are possible in the manufacturing process, auxiliary equipment, and power system. Improving salt and brine quality will also reduce the energy load. For a 100 tonne per day capacity plant, an investment of Rs. 500 million can result in annual energy savings of Rs. 89 million for a payback period of 5.6 years. Taking all costs into consideration the payback period reduces to 3.5 years.

Presently 33 units produce nitrogenous, 53 produce phosphatic and 29 small units produce single super phosphate fertilizer in India. In 1995-96, industry produced 8.76 million tonnes (Mt) of nitrogenous and 2.59 Mt of phospahtic fertilizer. Nitrogenous fertilizers, i.e. ammonia and urea fertilizers, are highly energy intensive employing natural gas, associated gas, naphtha, fuel oil, and coal as their major feedstocks. Gas-based ammonia plants represent the most energy-efficient technology in India, which compares well with that in other countries in the world. Salient international comparisons are shown in Table 1.

Table 1. Average Energy Consumption for Ammonia Plants

Country	**MkCal/t**
UK	7.4
Indonesia	8.2
Malaysia	9.2
India	**9.4**
USA	10.0
UAE	12.1

The age of the technology, the scale of the plant, and management practices have a large impact on energy efficiency of the overall process. A typical ammonia plant established in 1970s would be 600 tpd gas based process with an efficiency of 9.8 to 10.2 MkCal/t. A plant established in early 1990s would consume only 8.0 to 8.5 MkCal/t.

A typical energy efficiency revamp of an older (1970s vintage) ammonia plant would cost about Rs. 300 million, and will save about one MkCal/t of output, with cost of conserved energy just below the current (1998) energy prices assuming a levelized cost with 14% interest and 10 year capital life. An estimate of total potential energy savings from pre-1980 plants (assuming savings of 2 MkCal/t for ammonia plants and savings of 1 MkCal/t for urea plants) is 17 million MkCal annually, worth about Rs.5100 million at the 1997 price of natural gas.

Integrated primary steel plants in India usually employ the blast furnace-basic oxygen/open hearth furnace process route for iron and steel production. About 26% of the total steel production is through the open-hearth process, an obsolete technology by world standards. Secondary steel production takes place in mostly privately owned small steel plants employing the electric arc furnace process (installed capacity of 8.44 million TPA in 180 units) or the induction furnace process (installed capacity of 8.83 million TPA in around 800 units). New plants using the COREX process are also being built that will be much more energy-efficient.

Investments in basic oxygen furnace gas recovery could save 1.3 million tonnes of furnace oil with a payback period of 5.7 years. Improvements in coke drying units would result in even higher savings (Rs. 2500 million) with a payback period of only 3.4 years. Other measures lead to similar savings with payback periods mostly ranging below five years. With rising cost of fuel the estimated pay back periods are likely to reduce further.

3. IDBI Lending Process, Institutional Structure, Training, Information and Data Needs

IDBI was established in 1964 under an Act of Parliament for providing credit and other facilities for the development of industry. It also acts as the principal financial institution for coordinating the activities of institutions engaged in the finance, promotion, or development of industry. The Government of India's shareholding in IDBI amounts to 72%, and the rest of the shares are owned by the general public.

IDBI has also offered specialised schemes for energy conservation viz. Equipment Finance for Energy Conservation and Energy Audit Subsidy Scheme. Presently, IDBI provides rupee and foreign currency term loans for the acquisition and installation of energy conservation equipment, and for pollution control and prevention projects in highly polluting industrial sectors, funded *inter alia*, out of World Bank's Industrial Pollution Prevention Project (IPPP) or the US Agency for International Development-funded Greenhouse Gas Pollution Prevention (GEP) Project. Besides, finance is made available for EE/EM out of the on-going Industrial Energy Efficiency Project of the ADB of which the TA forms a part. Under this project, finance is given to industrial units in rupee as well as in foreign currency. Additional funding needs left unmet by the ADB funds are supplemented by IDBI's own funds as well.

3.1 IDBI Institutional Structure

IDBI is governed by a Board of Directors and its operation is carried out under the supervision of the Chairman and Managing Director assisted by four Executive Directors and one Adviser. With its head office in Mumbai, IDBI has 43 additional offices throughout India. As of November 1998, IDBI was structured into 33 departments, which are organized into five groups to facilitate proper distribution of responsibility. Among these departments, the ones relevant to the efficient lending for ee/em activities are briefly described below.

3.1.1 Project appraisal department. The Project Appraisal Department (PAD) appraises all the industrial project proposals. PAD projects constitute the majority of projects sanctioned by IDBI in terms of value. Besides a number of smaller projects are funded at the branch level.

3.1.2 Corporate finance departments. The three Corporate Finance Departments (CFDs) follow up on the projects that have already been sanctioned, in order to ensure their timely implementation and proper utilization of funds. In addition, a new concept of a Relationship Manager was instituted within the CFDs. These managers will be dedicated to manage IDBI's interactions with a major industrial (ownership) group, such as Reliance Industries, the Tata Group, etc.

While the relationship manager system works well from the perspective of consolidating knowledge about an industry group, it may not work as well where the focus has to be on an aspect of technology within an industry sector. For example, a relationship manager cannot be expected to be an expert on energy efficiency in every industry sector that forms a part of the industry group being dealt with by him/her. Hence, in order to develop some expertise in some of the industries, which are not necessarily dominated only by a few major industry groups, industry-sector-wise approach is also adopted. Thus the organisation of a CFD is a workable mix of industry group and industry sub-sector, with the expertise of one Dealing group drawn upon by another.

3.1.3 Forex services and treasury departments. The Treasury and Funding Division contracts, decides on utilization and monitors all lines of credit from multi-lateral institutions like the World Bank (WB) and the Asian Development Bank (ADB). It manages the various specialized loans and grants for energy and environmental technology projects, including this TA project.

3.2 Comments on Organizational Structure

IDBI's organization structure is driven by its business objectives of offering the best services to the major industry groups. At the same time it is so organised to have industry specialists in important industrial sub-sectors as well. The organisational structure is geared to provide the best products and services in the present competitive environment while simultaneously attempting to meet its developmental role governed by "issue-based" lending. Following financial sector liberalisation, the environment has turned highly competitive compelling IDBI to organise itself in a manner to prioritise the objective of offering the best services to the major industry groups over focus exclusively for energy efficiency and environmental activities. There is a need to create a "home or center" for energy and environmental technical activities. This center needs to be located at the highest level within IDBI in order to ensure visibility, and to provide a resource base, which could be accessed by all the concerned departments described above.

IEEP and other such lines of credit are being managed by the FSD, which is not directly engaged in either project appraisal or in implementation. Hence its role is one of being a facilitator and co-ordinator for giving the needed focus to the ee/em activities. It is quite possible for this Section to be upgraded to be the "home" suggested above with appropriate technical staff for policy making, facilitation of the lines of credit, developmental activities, etc. in ee/em issues. This will help clarify the varied roles of CFD and FSD and avoid duplication of effort, better coordination and communication between the FSD and the CFD. A system of built-in incentives for co-operation and co-ordination between the concerned departments will also aid the organisation in playing a more effective role in ee/em activities relating to policy formulation, loan approvals and subsequent disbursement.

3.3 IDBI Lending Procedure

The current procedure for lending at IDBI includes: (1) an inquiry stage, (2) an application stage, (3) site visits, (4) preparation of an appraisal note, (5) an evaluation by IDBI committee, (6) the issuance of a Letter of Intent, and (7) preparation of a legal agreement for lending for suitable projects.

IDBI also operates special credit lines for the mitigation of pollution, implementation of the Montreal Protocol commitments, modernization and expansion of energy intensive industry, etc. The technical norms for these lines were determined individually, but the lending procedure is the same as that for other IDBI projects.

The lending procedure followed by IDBI is comprehensive, based on accepted methods of evaluation and collective wisdom, and is transparent. The procedure, however, does not provide for a serious attempt to evaluate the energy and environmental components of any lending proposal. At each stage of the application for a loan, a company is required to provide information on energy consumption, along with that of other utility services. Energy consumption information is disaggregated into fuels and electricity categories. The company is not required to provide indicators of energy use to IDBI, which makes the information difficult to evaluate. Indicators could link the energy (fuel and electricity) consumption to physical activity levels and permit comparison with best practice in India and abroad. IDBI could also ask for additional information on technical indicators in the loan application that industries are required to complete.

3.4 Conclusions and Recommendations

Our evaluation of IDBI's institutional structure, lending procedures, and training and information needs revealed that there is a clear need for greater focus towards ee/em activities, by strengthening the existing institutional structure and capability in this area. This strengthening can be accomplished through the creation and establishment of a "resource center" that will provide the necessary technical backup for IDBI officers at all levels. The center resources will include access to technical experts, handbooks, and databases. The technical experts will assist in the organization of seminars, workshops, and training programs.

3.4.1 Energy efficiency indicators. It is important from the viewpoint of ensuring effectiveness of investments made in energy efficiency and environmental management loans that there should be an assessment of the cost-effective potential for improving energy efficiency. This assessment needs to be conducted at the time of evaluating the loan application (*ex-ante)*, as well as subsequently as the project is implemented.

Indicators are commonly used to assess the effectiveness of a proposed energy efficiency measure, and to compare the proposed measure against other alternate measures. There are several indicators in common use related to energy efficiency investments (e.g., simple payback period, rate of return on investment). However, these are unsatisfactory since they depend on the current (or projected) price of energy, and need to be recalculated every time that price changes. Other indicators, (e.g., the quantum of gain in energy efficiency achieved), are somewhat arbitrary since they do not incorporate the quantum of investment or change in operating and maintenance cost associated with the gain in efficiency.

A more appropriate indicator that is used in the industrialized countries is the Cost of Conserved Energy (CCE). This indicator is independent of the current price of energy, depends only on the technology and its use pattern, and appropriately incorporates the investment cost and changes in operating and maintenance cost associated with the change in technology.

4. Overcoming Barriers to Energy Efficiency

The Indian industry faces many types of barriers to improving energy efficiency. These barriers are grouped into five categories as described below (Meyers 1998). We discuss the relevance of each barrier with examples from the industrial sectors that were evaluated in this project, and comment on policies that have been or could be used to overcome the barriers.

4.1 Macroeconomic Conditions

These barriers pervade the Indian economy and affect the overall productivity of Indian industry. They inhibit energy efficiency improvements indirectly by maintaining conditions in which investments in energy efficiency are ignored, under-valued, or considered too risky by economic actors. The barriers include (1) low-level of competition among firms resulting from regulation of the domestic market and/or policies that constrain entry of imported products into the market, (2) high tariffs on imported goods, (3) low level of capital market development, and (4) high rate of inflation.

The Indian industry, particularly that in the public sector, has been affected by each of the above barriers, except possibly the third barrier. The manufacture of all the major products described above has been subject to varying degrees of control. Until the early 1980s, an administered pricing and licensing regime prevailed which allowed inefficiency in manufacturing to be the norm, and the inefficient Indian industry established during this period continues to operate to this day dragging the energy use parameters down for the industry as a whole. Overall productivity growth in Indian manufacturing has been slow at about 0.3% annually, and that for energy use has declined marginally (Mongia and Sathaye 1998).

The changes in the Indian economy since the 1950s and the impact of the government’s policy of liberalization in the 1980s, and opening up to foreign investors since 1991 are well documented elsewhere. Some industries such as pulp and paper were clearly affected by these changes, and about one-third of the current capacity is idle. Other industries, such as textiles and chemicals, are restructuring to respond to the new policy environment, and the government’s privatization of the public sector units should also lead to higher energy efficiency.

4.2 Energy Pricing

Energy pricing may not reflect the cost of supply that is borne by the supplier due to lack of marginal cost pricing or time-of-day pricing or the presence of price subsidies (which may involve cross-subsidies from one customer class to another, and/or subsidies from the government budget). In India, electricity price to agricultural customers is subsidized. The industrial sector, however, has paid a price above the average tariff, e.g. 70% above the average tariff, in 1994-95.

A related barrier is the vagaries of government policy with regard to energy pricing.

The Indian Aluminum plant in Belgaum, Karnataka, is a case in point. This plant has the capacity to produce both alumina and aluminum metal. The latter is very electricity intensive and requires a high quality of electricity supply. A few years ago, the Karnataka Power Corporation raised the price of electricity to the plant, which forced it to shut down the electricity-intensive aluminum production operation. The production of alumina is continuing today. The plant managers were unable to import naphtha in order to set up a captive electricity generation plant due to government regulations prohibiting its transport by road. Today the plant is not producing aluminum and the production capacity is lying idle due to lack of electricity supply and the government regulations that have prevented the company from setting up a captive power plant.

4.3 Institutional Weaknesses

Some industrial sectors have research organizations devoted to developing new technologies and improving productivity in Indian industry. Some of these play an important role in helping industry establish benchmarks and standards for energy efficiency. The textile research associations in India, ATIRA, BTRA, SITRA, and NITRA have established norms for thermal energy use by machine and plant type. Similar efforts are needed for other industries where many small firms dominate the industry, as in the case of paper mills.

Electric utility companies can be important actors in efforts to improve customer electricity use efficiency. In many countries, including India, a combination of their traditional supply-side orientation and lack of incentives prevents them from taking on a significant role. Even when there is good intention, staff may not be available to design and manage energy efficiency and environmental management programs. The State Electricity Boards (SEBs) in India, with a few exceptions, have not adopted programs to promote energy efficiency. The SEBs in India, have the expertise and know-how to play a large role in assisting industry in improving energy efficiency, either through offering incentives for energy efficient customers or through penalizing those who do not follow best practices by charging a higher tariff or a higher connection fee for example. The new regulatory boards being established at the center and state levels can provide the incentive structure for SEBs to promote the efficient use of energy by their customers. Efficient use will also help the SEB to eliminate or reduce electricity supply blackouts and brownouts.

Financial institutions often lack the experience with evaluating investments in energy efficiency or may be unfamiliar with international financing schemes that can best facilitate such investments. Improvements in financial institutions are needed to provide technical resources in the form of ee/em experts, sector-specific handbooks, databases, and training and dissemination workshops and seminars. The institutions can also secure lower cost financing from international lenders, the Global Environment Facility for example, and pass these incentives to their customers.

4.4 Market Behavior and Features

The macro-economic, energy pricing and institutional weakness barriers to energy efficiency play a major role in shaping decisions related to production and demand for energy-using technologies in a nation’s economy. The importance of particular barriers varies among specific markets. On the demand side, barriers tend to be greater with respect to small firms, than with large companies who are better able to evaluate investments. Similarly, in markets where the supply side is heavily comprised of small firms with low levels of technical, managerial, and marketing skills, the barriers to improving energy efficiency tend to be higher.

4.4.1 Barriers on the demand side of the market. Lack of information and limited access to financing, and "irrational behavior" are categories of demand-side barriers. Consumers and managers may lack information regarding the costs and benefits of technologies or services that deliver higher energy efficiency. Even when information is provided by technology suppliers, managers in firms and financing institutions may face difficulty in evaluating the veracity and applicability of claims made for a particular product or service. The paper and textiles industry in India is made up of hundreds of small firms that do not have the managerial capacity to track technical progress for instance. The caustic soda industry would benefit from more information on cell performance features of plants abroad, data on membrane stability at high current density, water conservation measures, etc. Demonstration projects done with full transparency can help to document the experiences and motivate industry to take up relevant initiatives.

Lack of access to financing has been cited by many Indian industries as a major barrier to improving energy efficiency. Financing may only be available for the short-term where long-term credit is needed. During the seminars organized for this project, industry pointed out that lack of financing for energy efficiency is a major barrier. Our findings, however, revealed that the IDBI, with its history of lead role in developmental activities, has had a number of schemes for ee/em purposes. While the schemes in the past provided an element of concession in finance and subsidy, the current schemes have limited such elements. The industry mind-set, particularly the small firms, expects concessions for ee/em activities. There are also instances where industry is unaware of such schemes. Greater outreach measures are therefore indicated.

"Irrational behavior" refers to the way in which individuals process and act on the available information. An industry's behavior may be inconsistent with its goals and more or better information alone may not be sufficient to change behavior, which is strongly influenced by habit or custom. Businesses may reject cost-effective energy efficiency investment opportunities, where management may deem these as too small a component of total production costs to warrant attention. Another equally important revelation is the preference for investment in increasing market shares over that in ee/em areas. This is because the industry management perceives greater market share and penetration to be more important than cost cutting by investment in ee/em areas.

4.4.2 Barriers on the supply side of the market. Limited availability of products and services, weakness of suppliers in market research and product development, and low level of information exchange within an industry are categories of barriers on the supply side. Individual industrial units may lack market power or knowledge about advanced designs and/or techniques to demand efficient goods from suppliers who normally carry limited product lines and are unable to offer choice of equipment with varying degree of energy efficiency.

Supplier weakness may result from firms lacking skills required for development of new products. The processes and networks by which learning takes place such as professional associations, conferences, publications and informal networks are often weak in India. The exchange of information was observed to be quite low within the paper industry during the seminar held on that topic as a part of this technical assistance. Motor Challenge, a US Department of Energy government/ industry partnership program, for example, provides ways to bring industry together to improve the efficiency of their stand-alone electric motors. The program offerings include: the Information Clearinghouse, which provides current information about the practicality and profitability of electric motor systems, design decision tools, demonstration projects and training workshops. Such a program would decidedly be of help to Indian industry.

4.5 Features of Energy Efficient Products and Services

Performance uncertainty, high first cost, higher transaction costs, and inseparability of product features are barriers that affect particular products or services. Performance uncertainty is most problematic for new and unfamiliar technologies, particularly those that are imported to a tropical climate. For instance, the manufacture of fertilizers using natural gas in a new plant in India requires 7.4 MkCal/Mt of product. While this value compares favorably with that abroad, it will always be somewhat higher since the ambient cooling water temperature is higher in India.

High first cost is a common feature of more energy-efficient technologies, and is a barrier for consumers and firms lacking in capital. The membrane process for the production of caustic soda in India requires more capital, although it has lower operating costs and is more energy efficient than the mercury process. Conversion of the mercury process to the membrane process is cost-effective with a relatively short payback period. Financing of such plants would significantly reduce electricity use per unit of production and eliminate further mercury pollution from existing plants.

The formation of energy service companies (ESCO) is an approach to overcome the performance uncertainty and high first cost of technologies. ESCOs established by (1) vendors focus on leasing or lending equipment, (2) bankers focus on providing attractive financing packages, and (3) utility companies focus on offering attractive electricity rates and services. Many types of ESCOs are already operating in the Indian market but more needs to be done to encourage their growth, and business practices need to be more transparent to ensure that ESCOs receive adequate returns through shared savings.

5. Conclusions

This technical assistance project identified the potential for improving energy efficiency in ten industrial sectors of the Indian economy. It examined the barriers to improving energy efficiency and suggested ways by which IDBI could increase and improve its lending for energy efficiency projects. The study identified technical options that were common to all sectors, such as efficient lighting, high efficiency electric motors, pumps, compressors and drives, computerized process controls, waste heat utilization, and installation of captive power plants. In addition, it identified options that were process-oriented and thus specific to each type of industry.

The potential for investment in each sector varies with the types of options that are identified above (Table 2). For example, the investment potential in the fertilizer industry is estimated to be around Rs. 5 billion, and that for cement industry is around Rs. 3 billion. These estimates are based on the cost-effective technical potential without taking into consideration the practical challenges or the current industrial stagnation, which would reduce the. The total cost-effective potential identified in the study sectors for improving energy efficiency either through retrofits or through process modernization amounts to about Rs. 45 billion, as noted in Table 2.

Table 2. Energy Efficiency Investment Potential in India

Aluminum	: Rs. 8,400 million
Cement	: Rs. 3,000 million
Chemicals (Caustic Soda)	: Rs. 5,000 million
Copper	:Rs. 250 million
Fertilizer	: Rs. 5,000 million
Iron and Steel	: Rs.10,000 million
Pulp & Paper	: Rs. 5,000 million
Sugar	: Rs. 3,200 million
Textiles	: Rs. 9,000 million
Zinc	: Rs. 150 million

The factors that keep energy efficiency low vary among the sectors. Small plant size is an important reason in several sectors, such as paper, sugar, textiles, zinc, and copper. The historical inattention to energy efficiency, and indeed overall productivity, is evident in sectors such as steel, aluminum, paper, sugar, etc., where administered pricing of fuels and electricity, high import tariffs and protection from lower cost imports enabled industry to purchase and install inefficient technology. Lack of information and demonstrated benefits of sophisticated technology, lack of professional associations and informal networks, high first cost of energy efficient technology, are some of the other barriers that slow or prevent its penetration in Indian industry. A key barrier, however, is the institutional weakness in promoting energy efficiency and better environmental management. Some sectors such as textiles have research institutions that provide information on energy efficiency, and the Indian government has established the Energy Management Center and the National Productivity Council to study and promote efficient use of energy. The research and studies, however, have not been fully deployed into energy efficiency projects. .

Financial institutions, such as IDBI, are in a position to help industry overcome some of the key barriers in order to spur the deployment of energy efficient technology and techniques. The financial institutions, however, need to consolidate the necessary technical expertise and make a concerted effort in the energy efficiency and environmental management field if they are to have a significant impact. We recommend that IDBI establish a *"resource center"* for this purpose. The resource center would have or be equipped to (1) call upon the necessary technical expertise, (2) collate and maintain data for industry to use, (3) prepare handbooks for each industry sector, and (4) publicize the importance of energy efficiency and environmental management, through the issuance of annual reports, and by establishing an award for best practice. Given the substantial scope for investment identified by the sector studies, such a resource center could serve as a strong asset to IDBI officers in particular and the Indian industry in general.

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